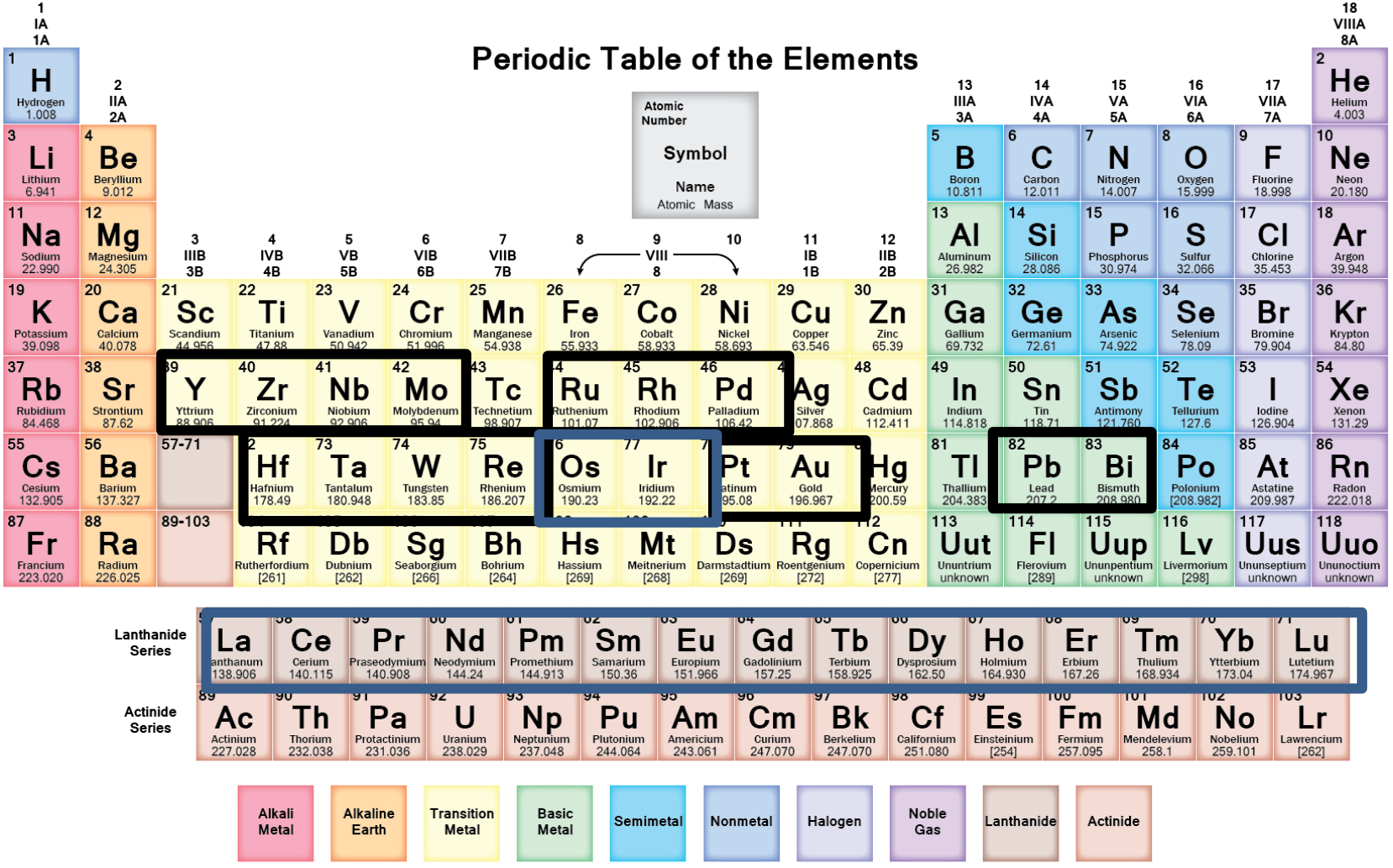
UCD Activities

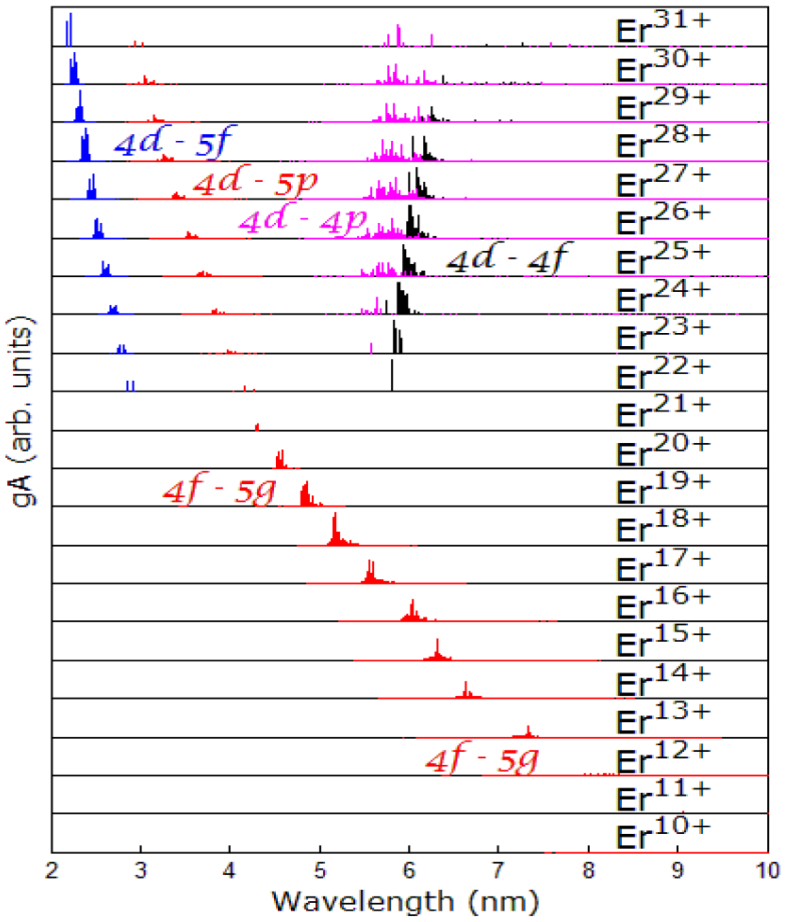
Spectroscopy Group Research

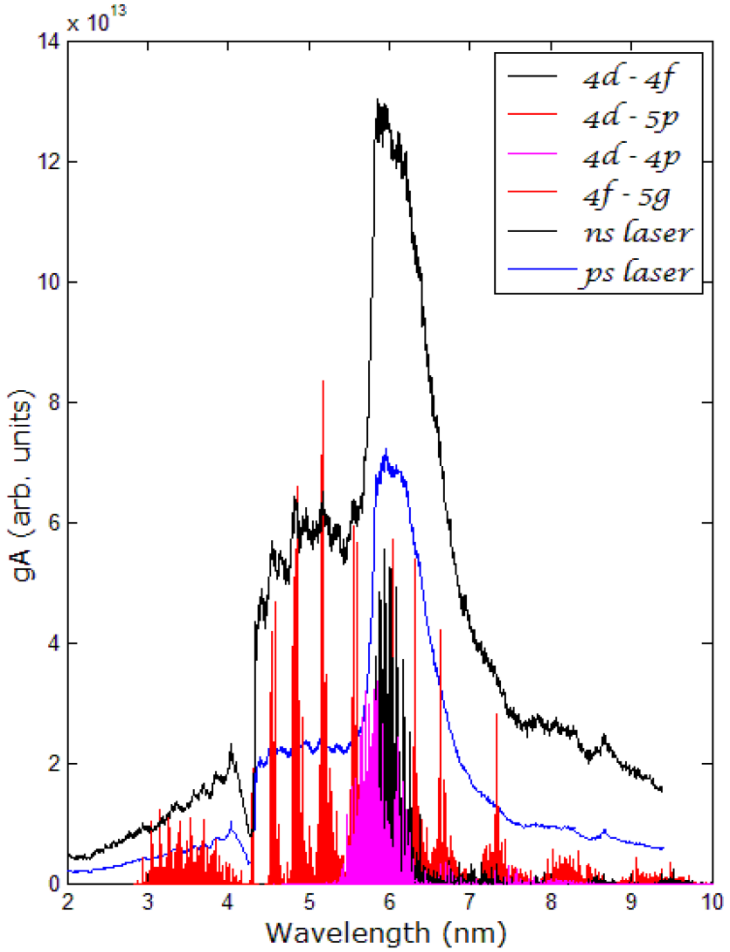
Nov 2015

SXR emission from Δn = 0 and 1 UTAs in high Z elements

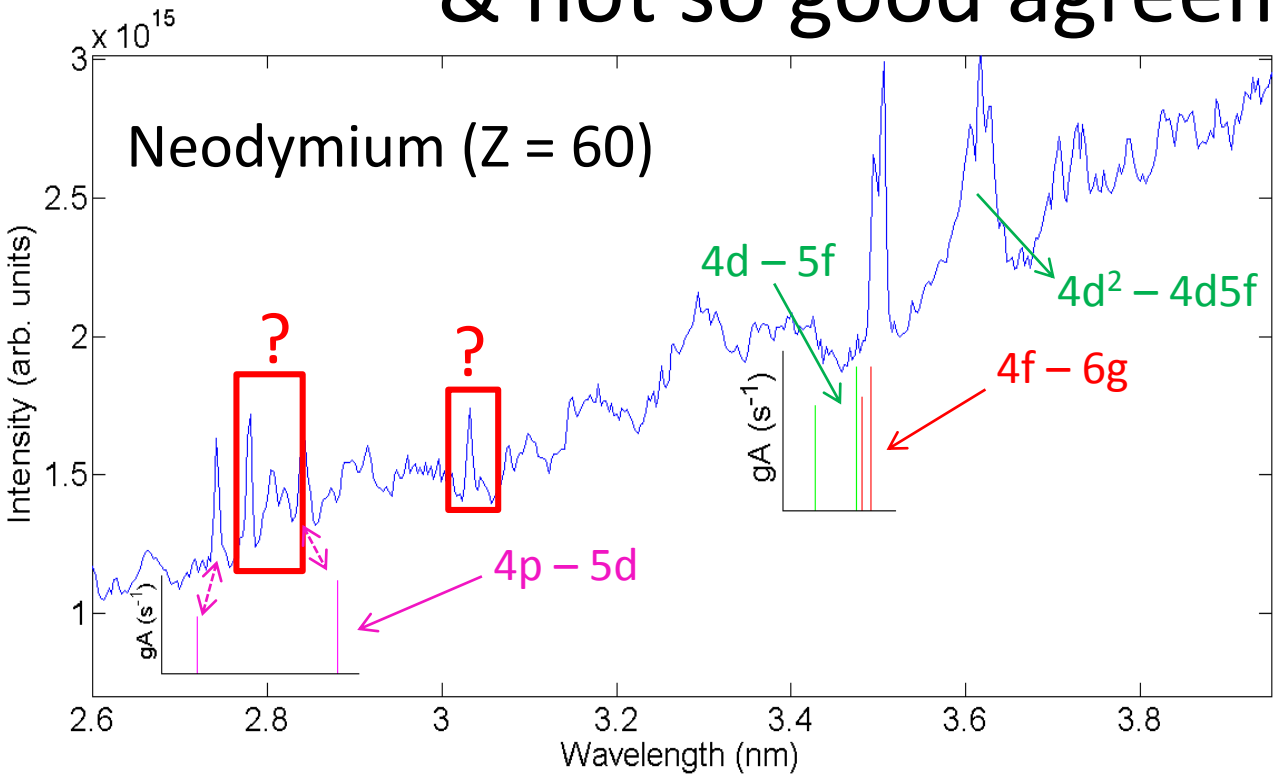


Rare Earth emission spectra e.g. Er: good agreement with theory





& not so good agreement:



10 ns laser (FWHM)
@ 600 mJ

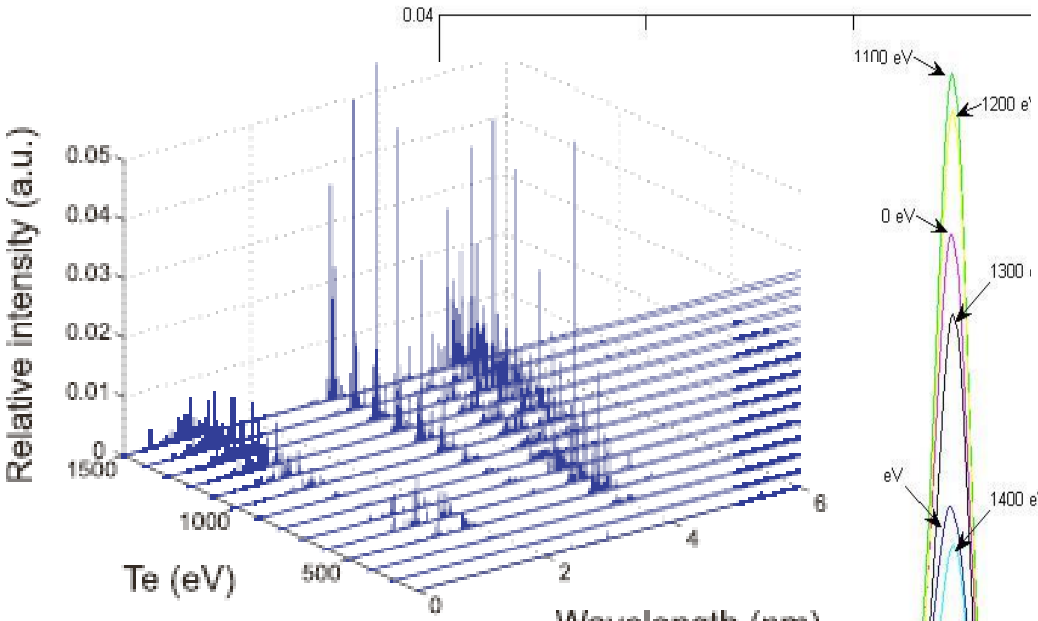
Hartree-Fock with configuration interaction Cowan code calculations $(0.9F^k, 0.9G^k, \zeta)$

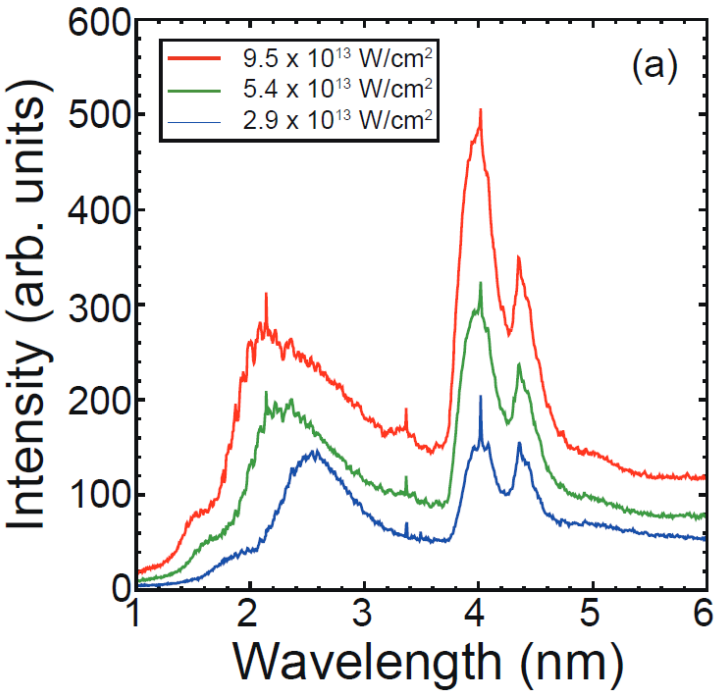
More unidentified lines!!

Sequence	Transition	λ(Exp.) nm	λ(Th.) nm	gA 10^{11} s^{-1}
Rb	$4f\ ^2F_{7/2} - 6g\ ^2G_{7/2}$		3.49191	3.1
Rb	$4f\ ^2F_{7/2} - 6g\ ^2G_{9/2}$		3.49112	108.1
Rb	$4f\ ^2F_{5/2} - 6g\ ^2G_{7/2}$		3.48103	84.1
		3.506		
		3.497		
Rb	$4d\ ^2D_{5/2} - 5f\ ^2F_{5/2}$		3.48021	3.1
Rb	$4d\ ^2D_{5/2} - 5f\ ^2F_{7/2}$		3.47527	62.7
Rb	$4d\ ^2D_{3/2} - 5f\ ^2F_{5/2}$		3.42747	45.8

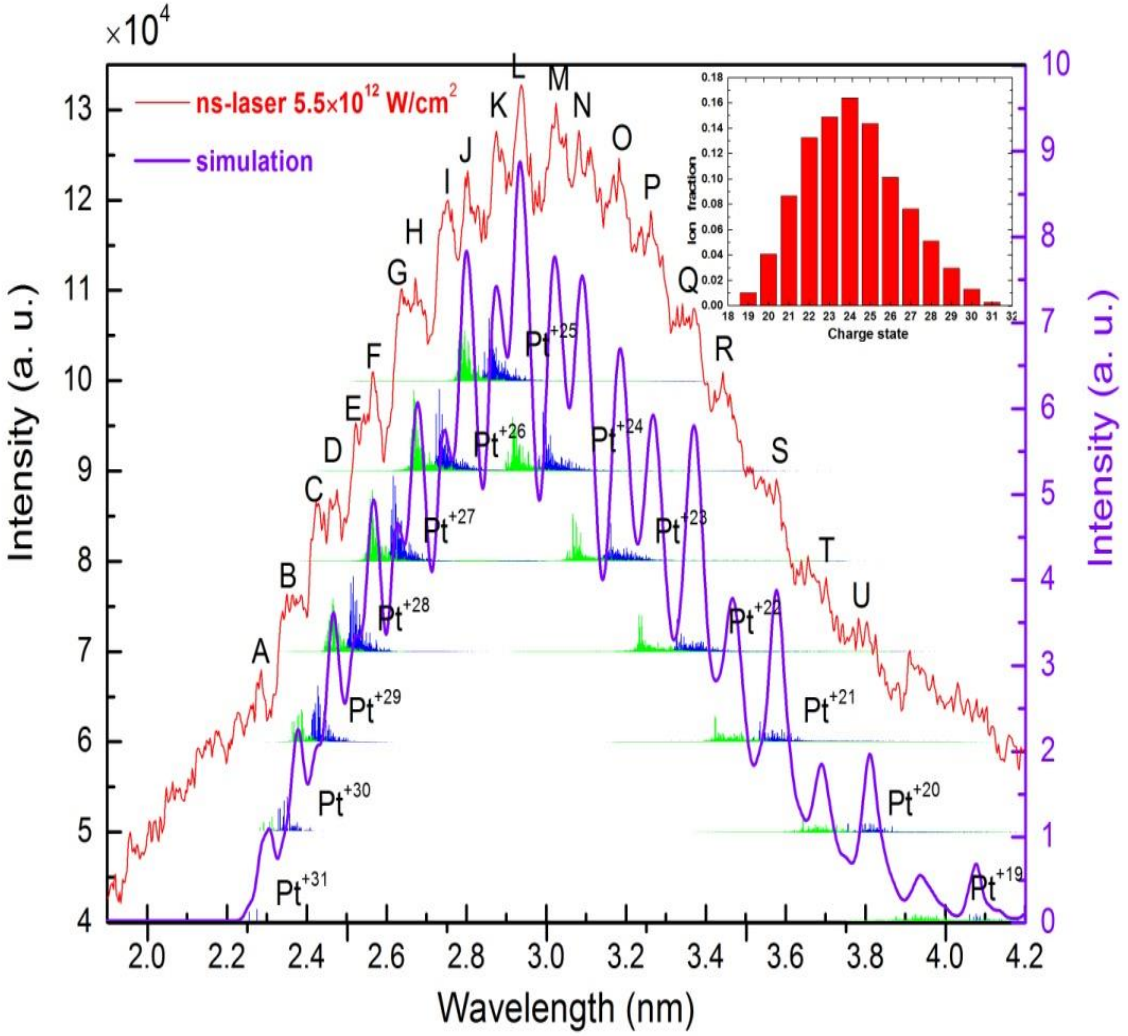
Simulation for Bi predicts 3.5 nm UTA

Calculated gA value distribution predicts strong 4p-4d array at 3.5 nm. Does it really exist?





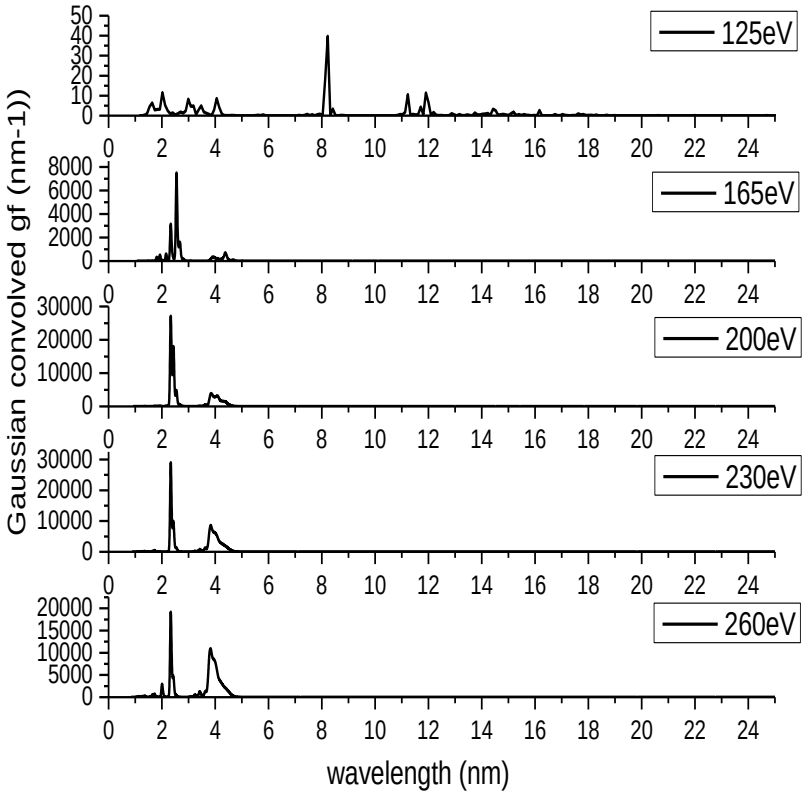
Ion population information from Δn=1, 4f-5g transitions



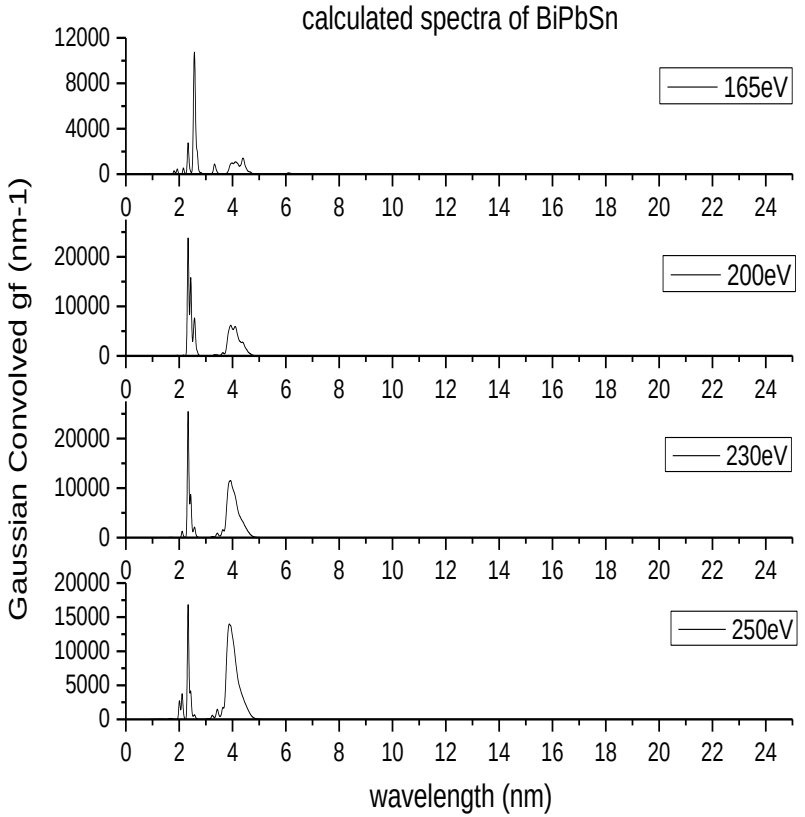
Study 5f-5g emission from a number of elements and compare populations with CR model predictions.

Of particular interest for studying ps spectra

Spectra of Rose's metal and Field's metal for water window source use.

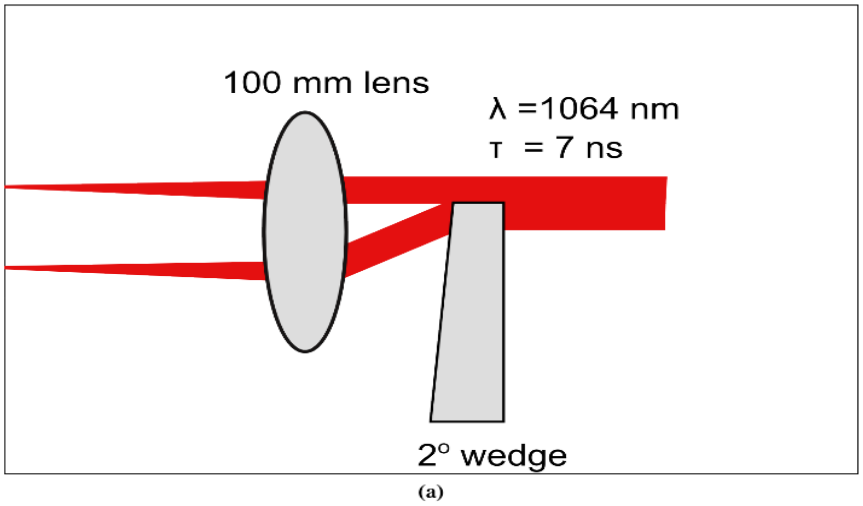


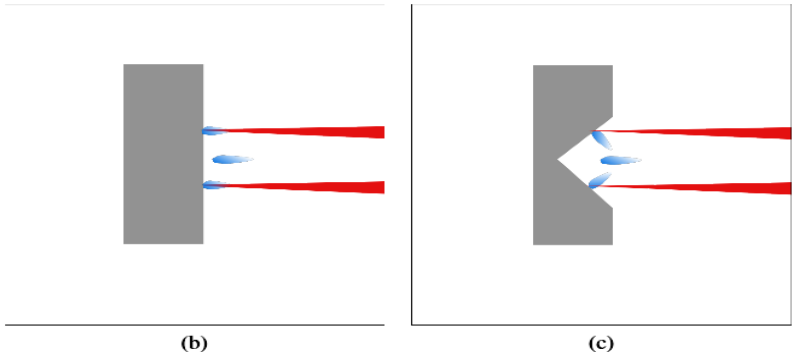
Calculated spectra of Field's metal



Calculated spectra of Rose's metal

Colliding plasma experiments





2 geometries studied:

- Flat target
- Wedge

- Is possible to tune the plasma density and temperature to make an efficient target.

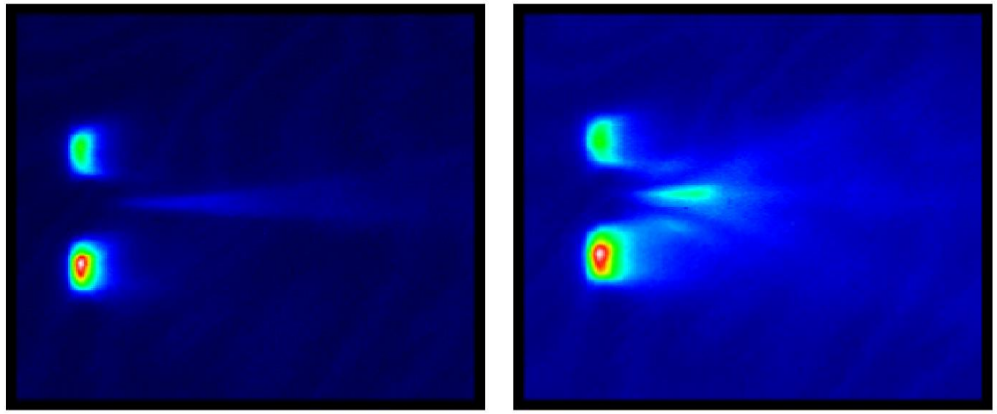
- Relatively long, stable lifetime. Plasma stays together longer – so it can emit for longer.

Flat target colliding plasma

Visible imaging

Nd:YAG colliding plasma

Nd:YAG colliding plasma + CO_2 reheat

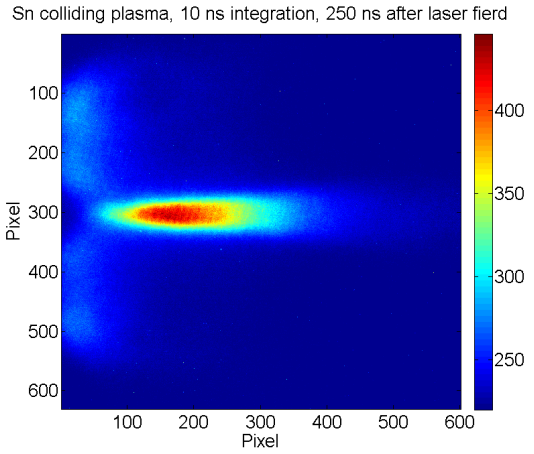


- Highest ion stages emitted along target normal
- Highest ion KE is along target normal

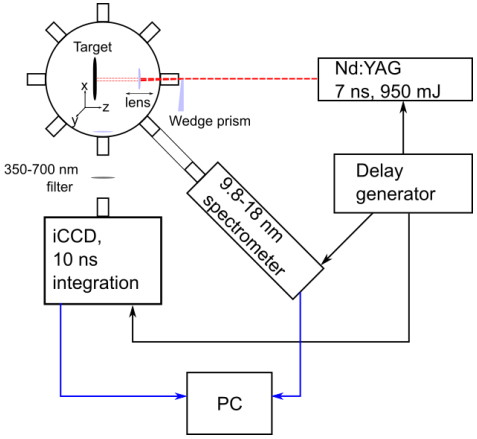
Sharply defined stagnation layer

Studies on C, Si, Ge and Sn
Measurement of ion velocities, plasma temperature etc., and comparison with calculations

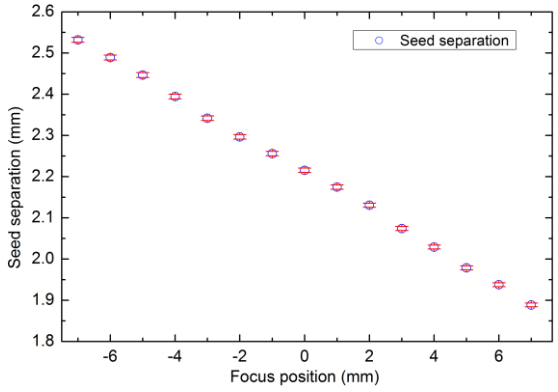
Colliding laser produced plasma imaging experiment



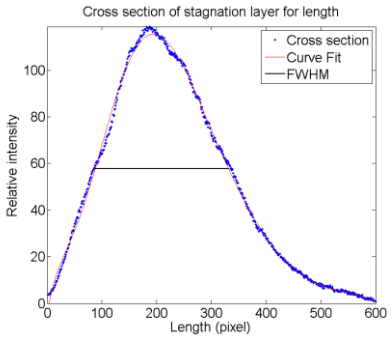
Stagnation layer image on iCCD



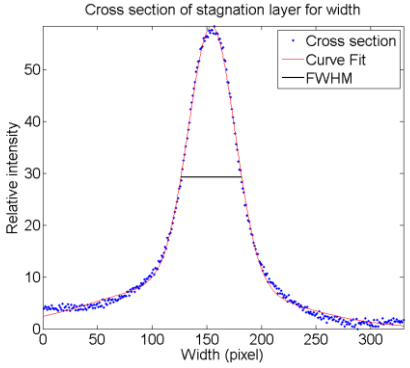
Experimental setup scheme



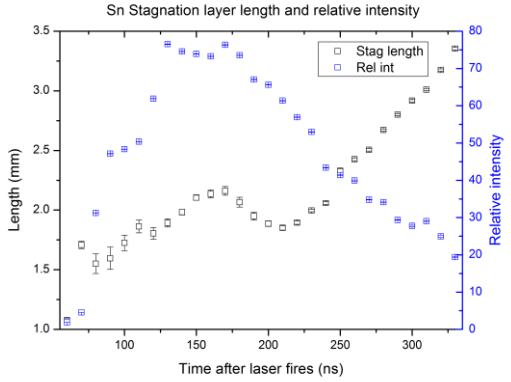
Seed separation based on lens position



Cross section of stagnation layer

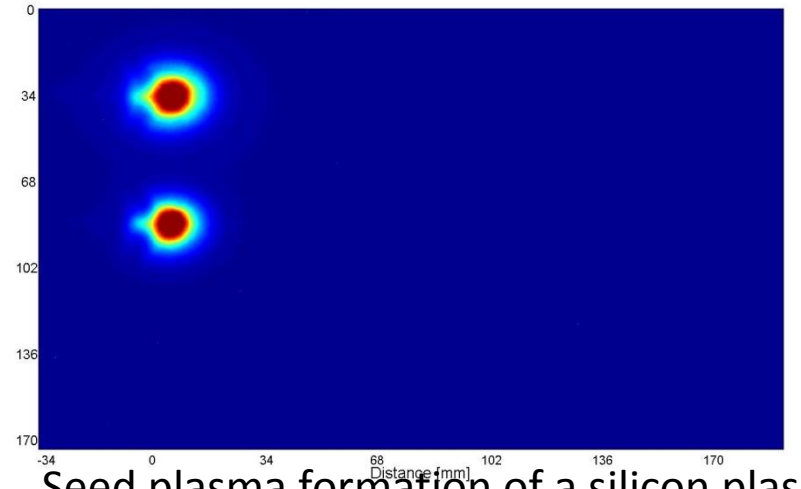


Cross section of stagnation layer

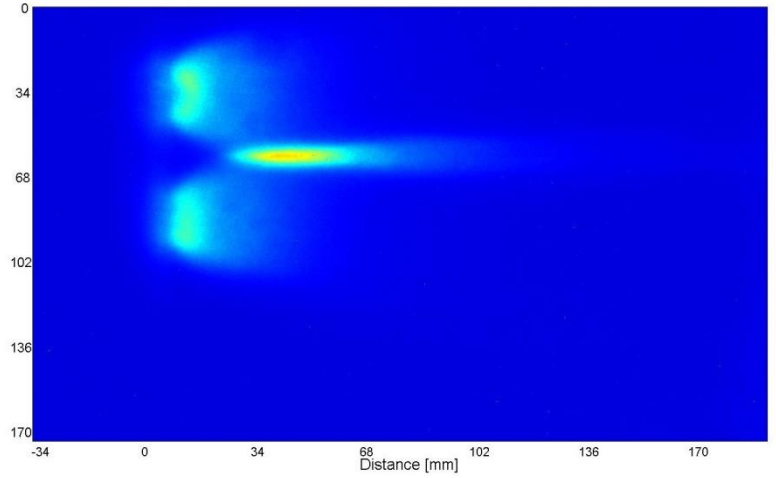


Length and intensity of Sn stagnation with lens in focus

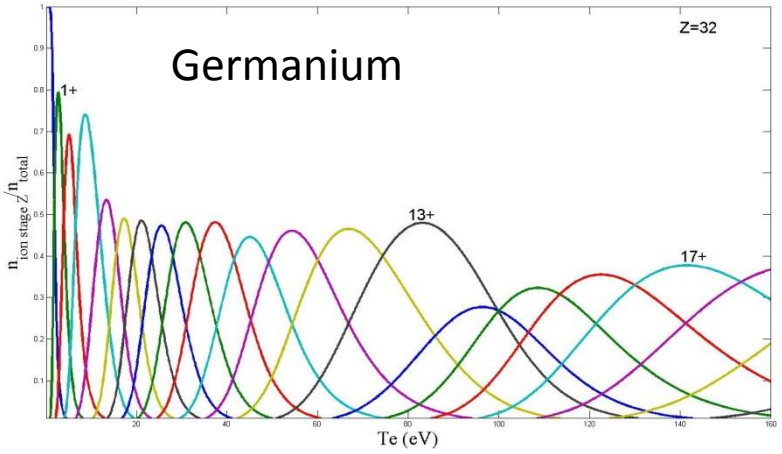
Colliding LPP experiments on carbon group elements

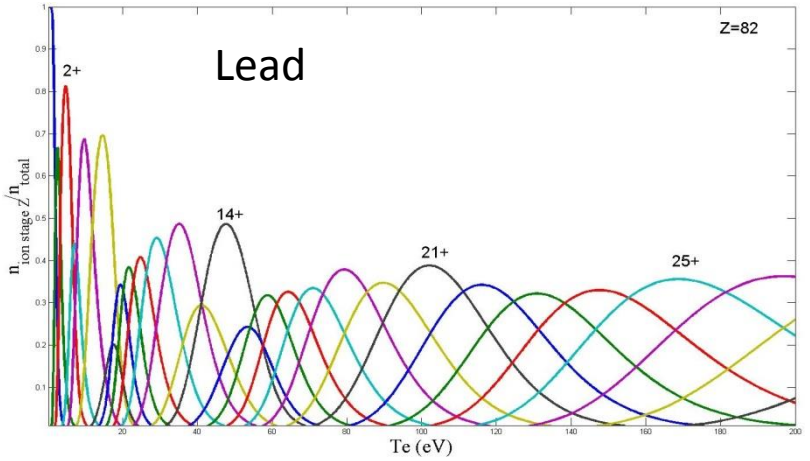


Seed plasma formation of a silicon plasma



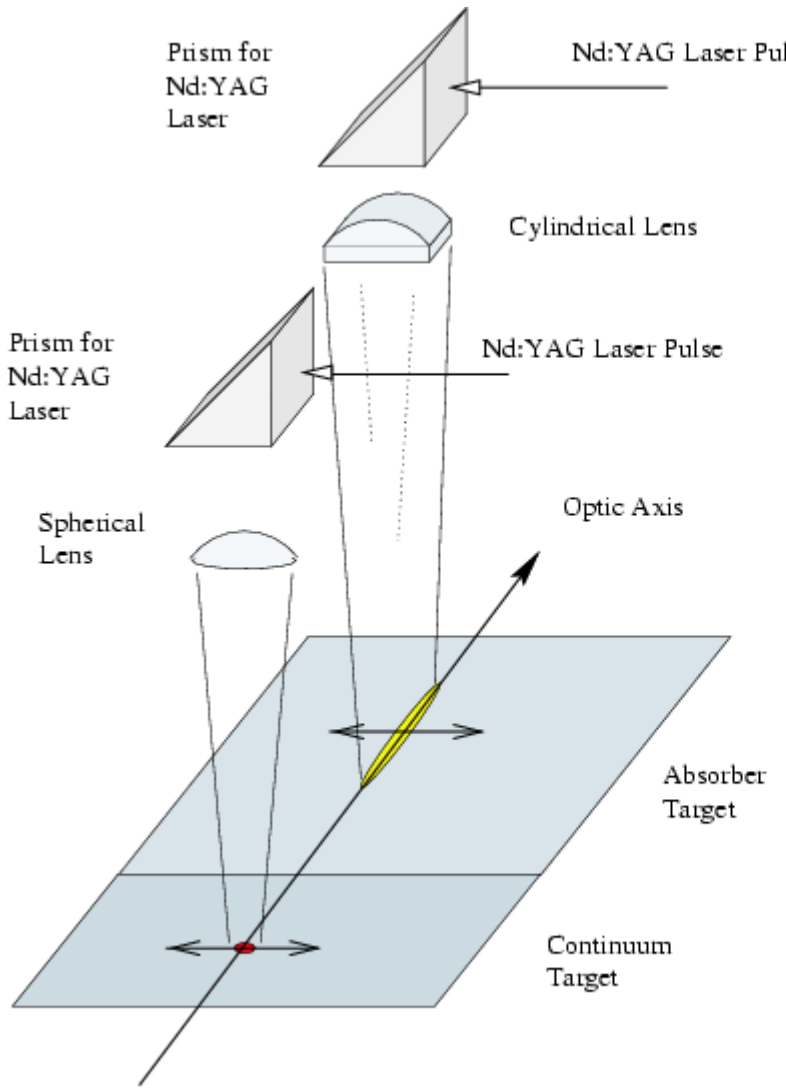
200 ns after plasma formation





CR ratio of the ionisation stages for increasing temperature, this model was developed by Colombant and Tonon, “X-ray emission in laser-produced plasmas.” Journal of Applied Physics **44.8**: 3524-3537

Photoabsorption: dual LPP technique

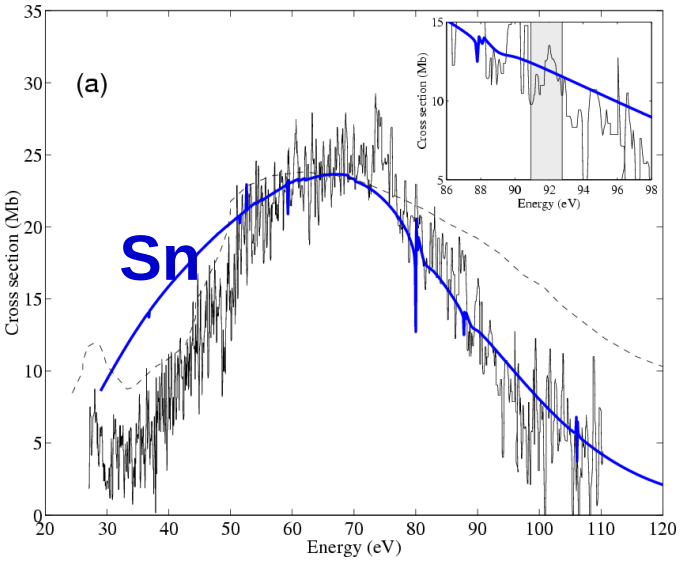


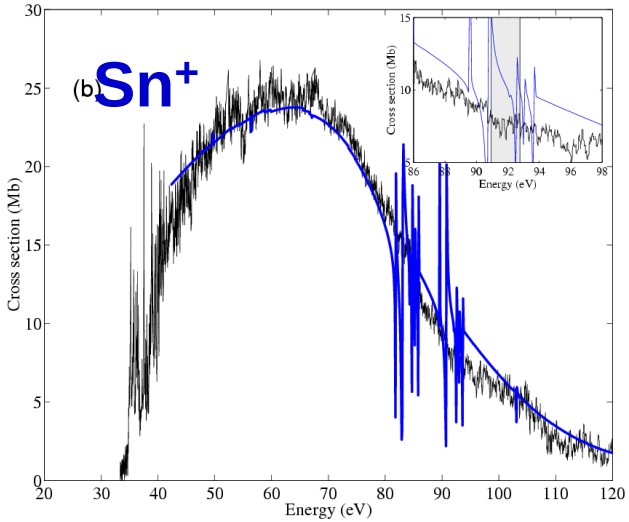
Experiment:

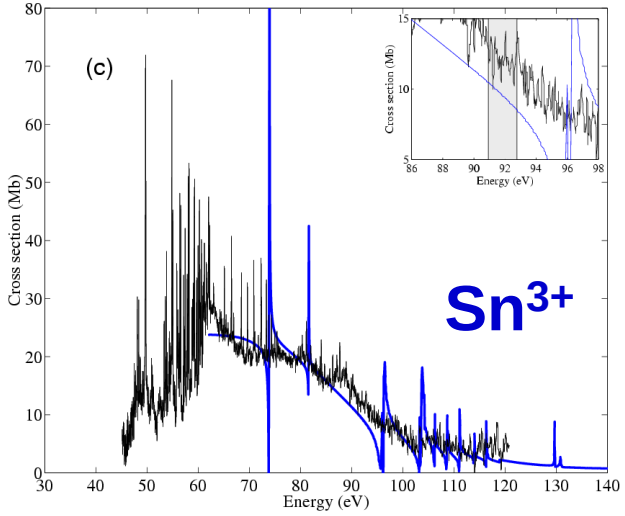
Dual Laser Plasma Method.***(Costello et al Phys. Scr. 1991, T34, 77-92, 1991)***

1 mm line LPP on target probed by EUV continuum emission from a Sm LPP at different time delays $\Delta\tau$ between pulses.

Photoabsorption of Sn, Sn^+ and Sn^{3+}, and comparison with calculation





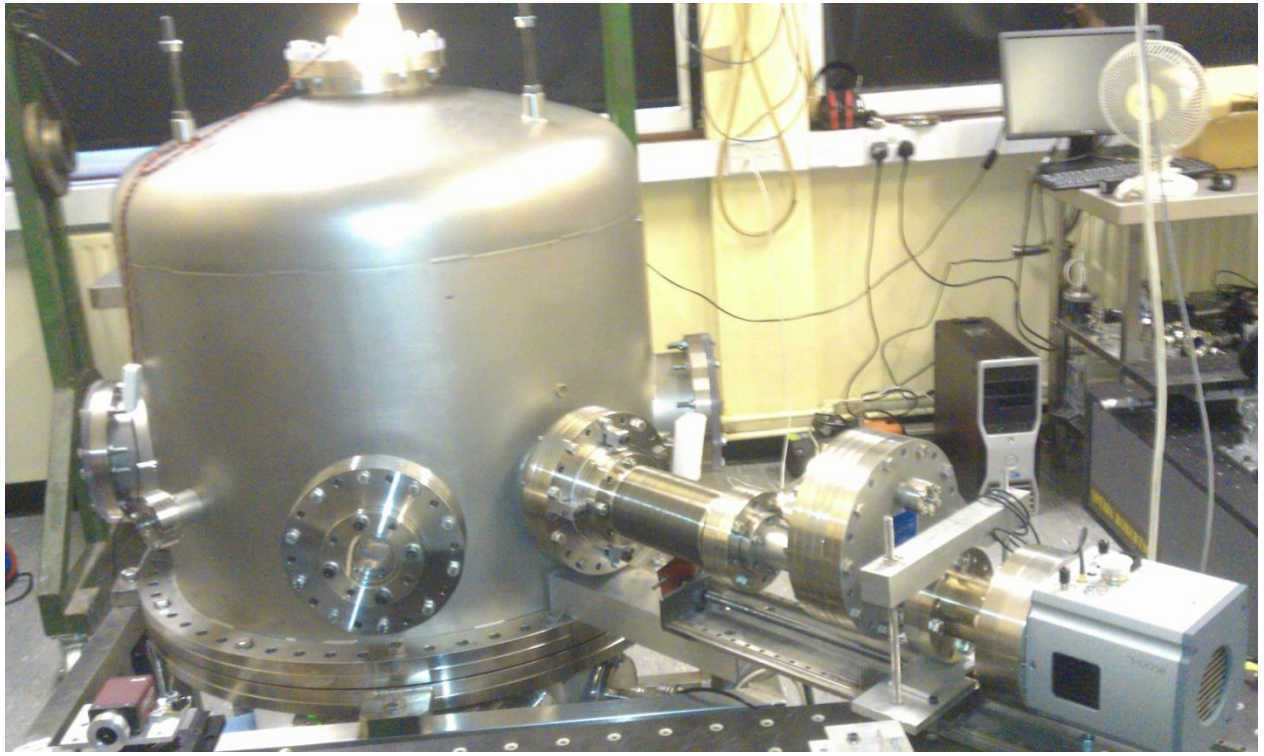


Theory:
TDLDA Code **David**
Zangwill and Libermann 1984 Comput. Phys. Commun. 32, 75.

Result:

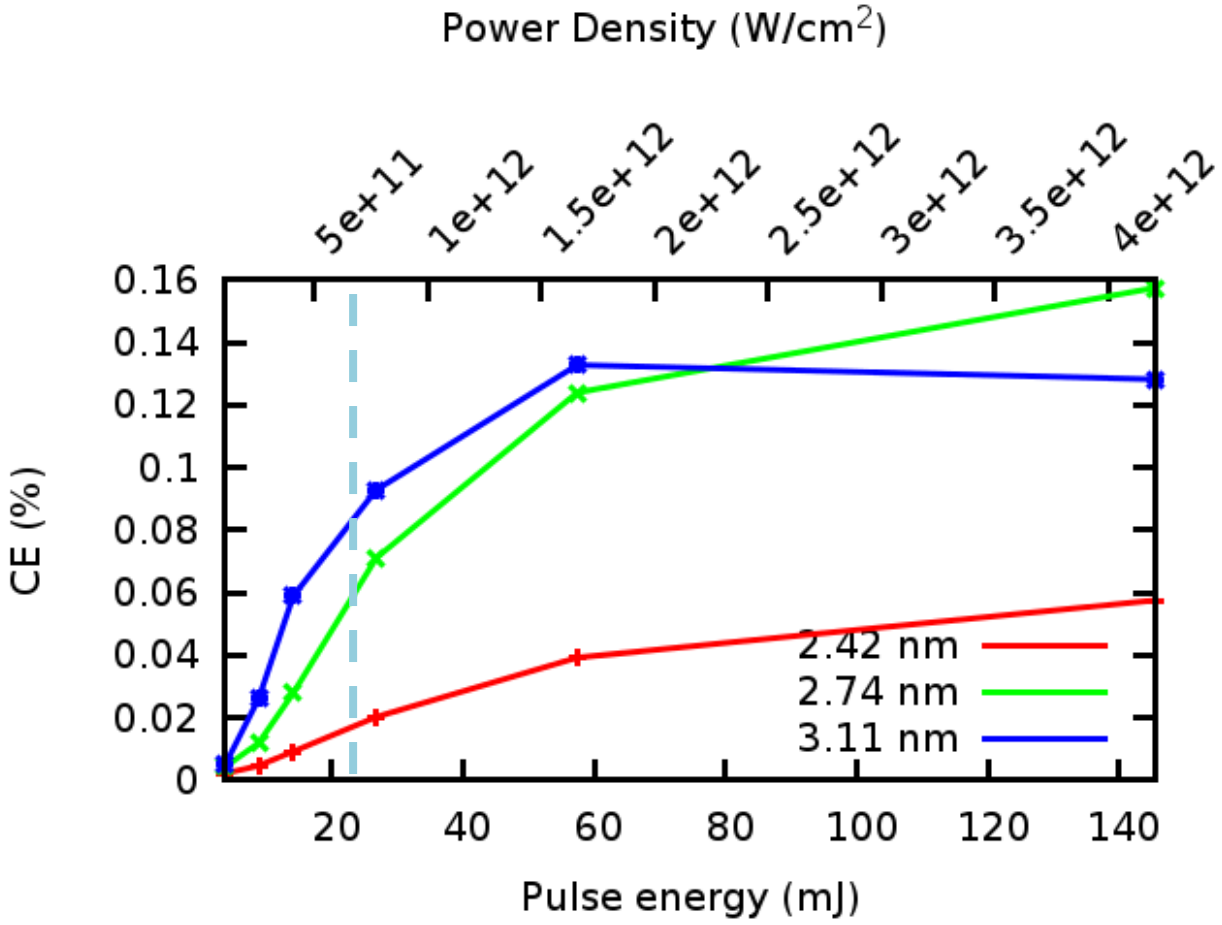
$$\sigma = 10 \pm 2 \text{ Mb}$$

Water Window Source Operational



Total Source Footprint is < 1 m x 1 m

Conversion Efficiency Mo (0.2% BW)

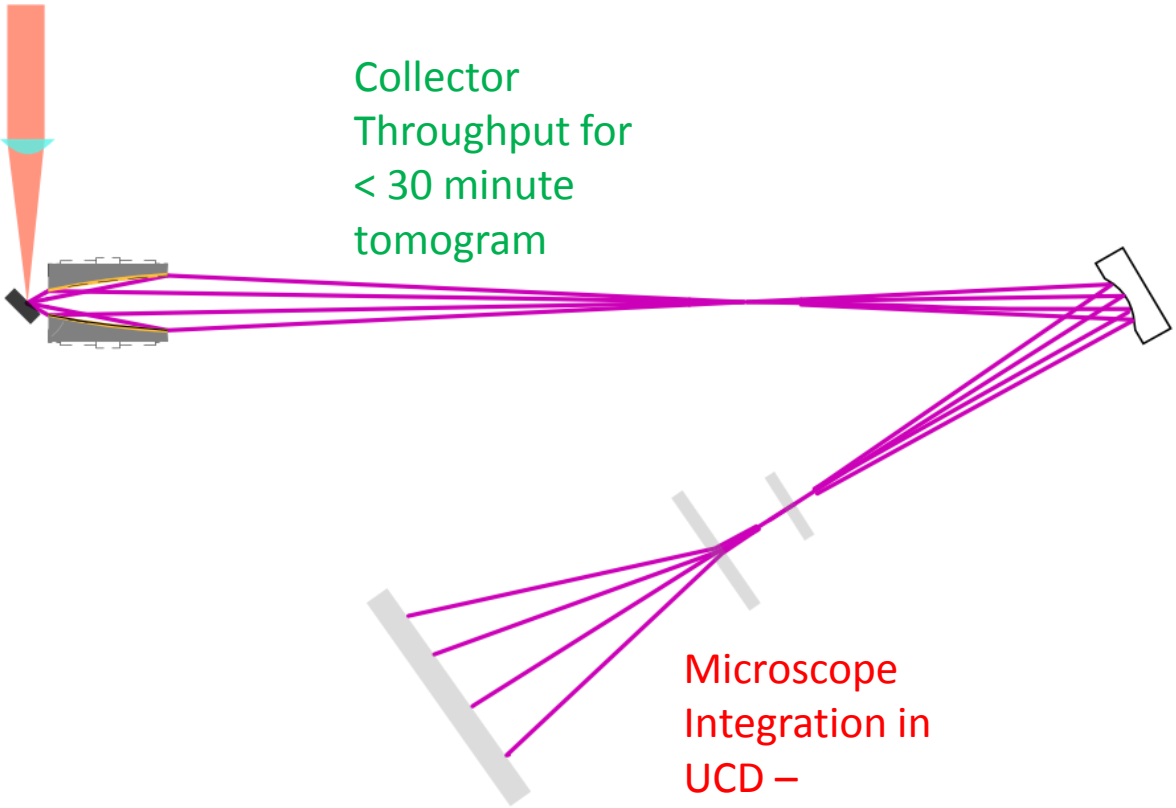


SXT Microscope Integration Underway

Source Stable

Photons from Plasma
< 30 minute tomogram

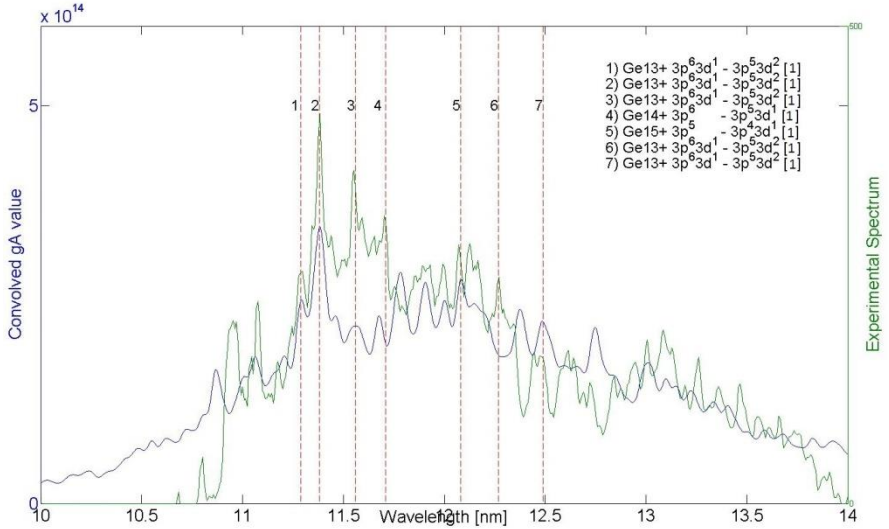
Collector Throughput for
< 30 minute tomogram



Microscope Integration in UCD – November 2015

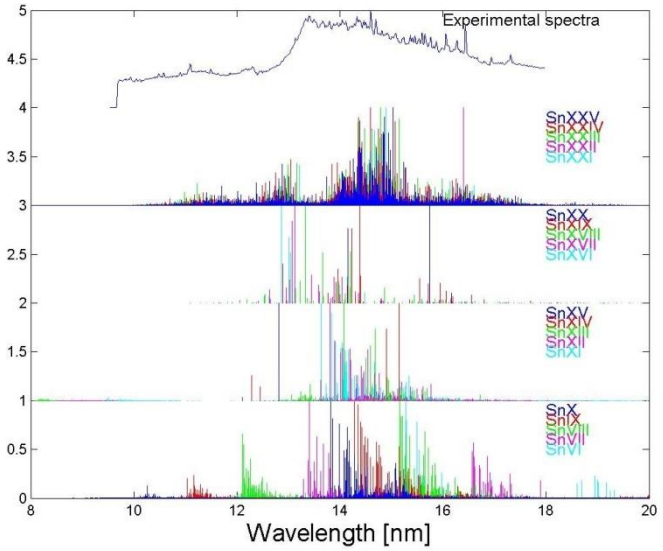
Thank You





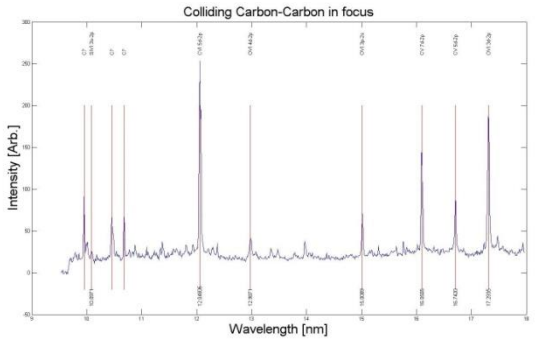
Germanium

[1]Li et al "Properties of the extreme ultraviolet emission from germanium and gallium plasmas." Journal of Applied Physics **118**, 073302 (2015)

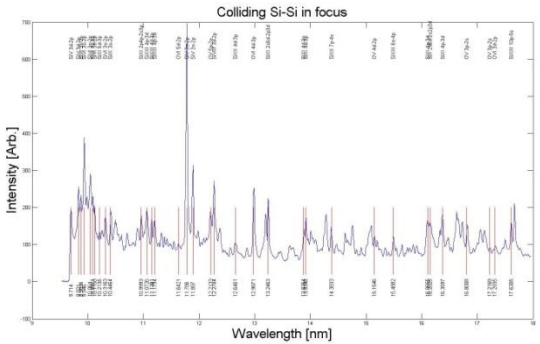


Tin

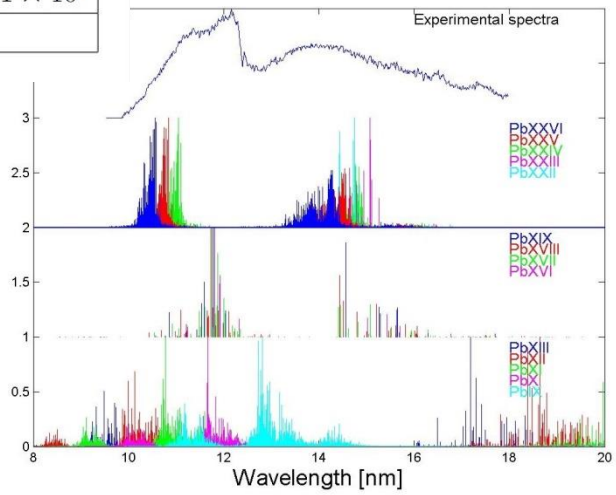
	Power Density $[W/cm^2]$	Temperature CR model $[eV]$	Temperature Spectra $[eV]$	Ion Velocity CR model $[m/s]$	Ion Velocity Camera $[m/s]$	Ion Velocity Probes $[m/s]$
C	$6.80 \pm 0.05 \times 10^{11}$	104 ± 2	78 ± 15	$4.09 \pm 0.02 \times 10^4$		
Si	$6.80 \pm 0.05 \times 10^{11}$	120 ± 2.5	123 ± 5	$2.91 \pm 0.01 \times 10^4$	$2.78 \pm 0.41 \times 10^4$	$2.85 \pm 0.25 \times 10^5$
Ge	$6.80 \pm 0.05 \times 10^{11}$	145 ± 3	100 ± 10	$1.96 \pm 0.05 \times 10^4$		
Sn	$6.80 \pm 0.05 \times 10^{11}$	159 ± 3.5	165 ± 4	$1.61 \pm 0.01 \times 10^4$	$1.08 \pm 0.41 \times 10^4$	$1.69 \pm 0.11 \times 10^4$
Pb	$6.80 \pm 0.05 \times 10^{11}$	175 ± 4	160 ± 10	$1.28 \pm 0.01 \times 10^4$	$1.86 \pm 0.41 \times 10^4$	



Carbon



Silicon



Lead